

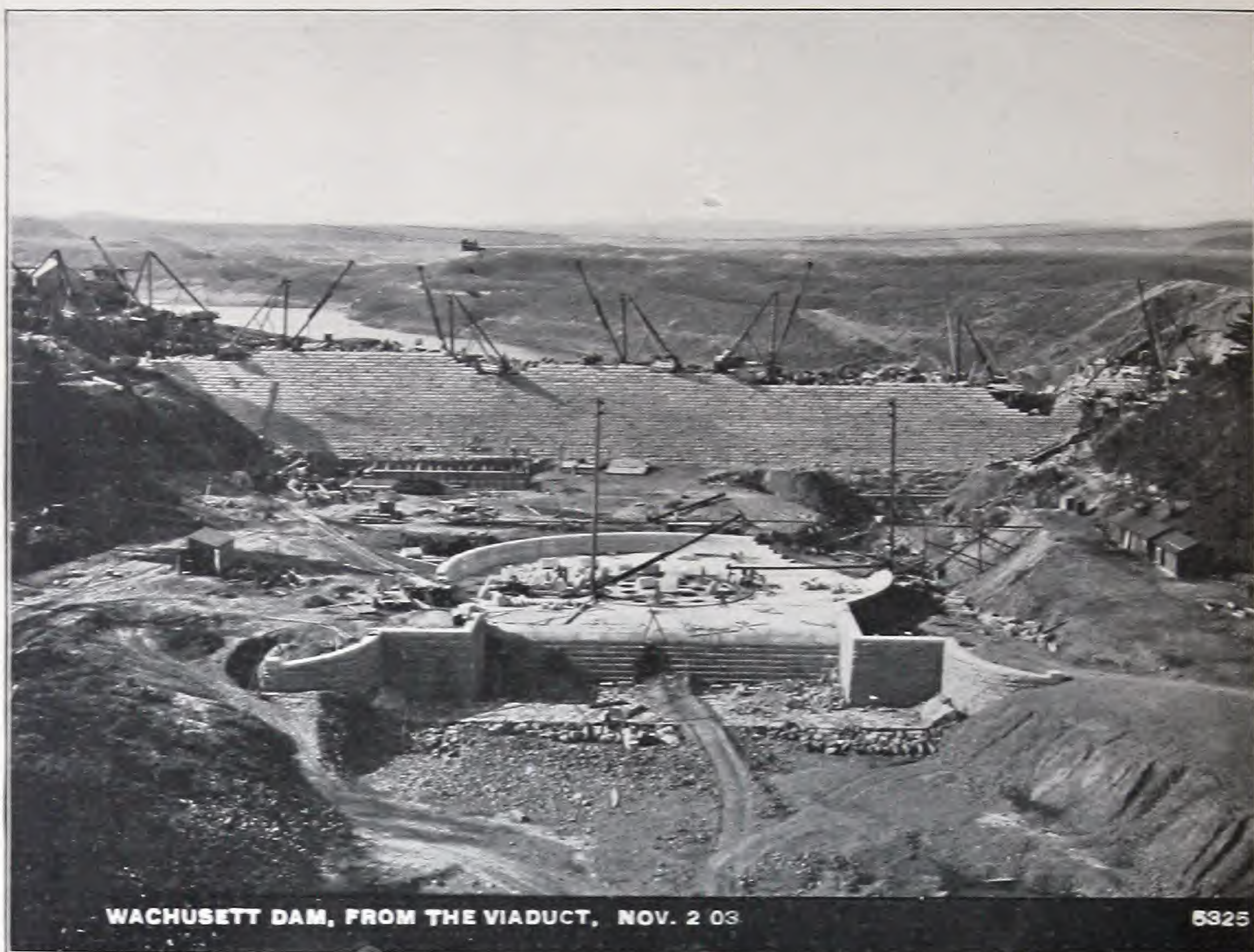
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JUN 30 1906

# Natural Rock Cement

A Discussion of Its Selection, Comparative  
Value, and Economy

1906



WACHUSETT DAM, FROM THE VIADUCT, NOV. 2 03

5325

THE WACHUSETT DAM, AT CLINTON, MASS.  
METROPOLITAN WATER SUPPLY, BOSTON

F. P. Stearns, Chief Engineer

T. F. Richardson, Department Engineer

Length of Dam, over 1,250 feet. Height of Dam, over 200 feet above foundation. Thickness of Dam, 25 feet at water level. Thickness of Dam, 176.3 feet at bottom. Storage Capacity, 63,000,000,000 gallons.

"Giant" Portland and "Union" Cements used.

Completed in 1905.

66,000 Barrels Giant Portland and 182,500 Barrels "Union" Natural Cement Used.

See Tests of "Union" Cement in Table No. 2.

UNITED BUILDING MATERIAL COMPANY,  
101 Milk Street, Boston, Mass.

CLINTON, MASS., April 21, 1906.

Gentlemen:—

It gives me pleasure to furnish you the following information regarding cement used in the construction of the Wachusett Dam of the Metropolitan Water Works of Massachusetts.

In the construction of this dam about 264,000 barrels of cement was used, of which 182,000 barrels was Union natural cement and 66,000 barrels Giant Portland cement, both of these brands being manufactured by the American Cement Company.

The cement has been continuously and carefully tested, tests being made both at the place of manufacture and in the laboratory at the dam; and both brands of cement have been found uniformly excellent.

I have been particularly pleased with the Union natural cement. Our specifications provide that the natural cement to be used in the dam shall be equal in quality to the best Rosendale cement, and Union cement was accepted as fulfilling these conditions, and particularly on account of its fine grinding and remarkable sand-carrying qualities. While this cement gained strength slowly, and is not suitable for using when subject to the action of frost immediately after being placed, at the end of a year our tests indicate that mortar composed of two parts of sand to one part of Union cement is as strong as most Portland cement mortars of the same proportions.

Our tests of cement used at the dam cover periods up to three years, and we find that mortar composed of two parts of sand to one of Union cement has a tensile strength of 413 pounds per square inch, while the average of all the Portland cement mortars, mixed with the same proportion of sand, used at the dam for the same period is 380 pounds.

The Union cement shows a continual increase in strength up to three years, while most of the Portland cements which have been used in the construction of the dam show a falling off in strength after the 6 or 9 months' tests.

I consider the Union cement superior to any of the natural cements which we have in this market.

Yours truly,

T. F. RICHARDSON,

Engineer, Dam and Reservoir Department,  
Metropolitan Water and Sewerage Board.

# The American Cement Company

EGYPT, LEHIGH COUNTY,  
PENNSYLVANIA

Manufacturers of

The "Old Reliable" "GIANT" Portland Cement  
And the Superior and Well Known Brand of  
"UNION" NATURAL ROCK CEMENT

Established 1884

---

Sales Agents

Lesley & Trinkle Co.,  
604-610 Pennsylvania Building,  
Fifteenth and Chestnut Sts.,  
Philadelphia, Pa.

The United Building Material Co.,  
320 Broadway, New York,  
101 Milk Street, Boston, Mass.

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Write for our booklet "THE TEST OF TIME"

10-86-B4916 TCE



# NATURAL ROCK CEMENT

## A Discussion of its Selection, Comparative Value and Economy

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### SELECTION

Engineers, Architects, and large users of cement are now quite generally basing their opinion of the value of a cement upon its composition, uniformity, and, last, but not least, its record in practical use.

The variety and difference in the chemical and physical characteristics of Natural cements may be known only to those who have enjoyed the opportunity of extended work in the Easterly, Middle, Southern, and Western States, and yet a greater difference is found between the several Natural cements than between a selected brand of this grade of cement and the best of the Artificial Portland cements. This is due in large measure to the great difference in the composition of the rock from which the cement is made.

The typical comparative analysis of leading Natural cements from the three principal producing sections will serve to show this, and the analysis of leading Foreign and Domestic Portland Cement is also given as a basis of comparison. [See Table on page 4.]

To those at all versed in the chemistry of cements, the superiority of Union cement over any of the Rosendale brands is plain to be seen — low in magnesia, — with a lime, silica, and alumina content more nearly approaching the Portland Standard than any of the Rosendale cements.

A few tensile tests from leading laboratories and large Public Work covering many thousand barrels of cement used will confirm this conclusion. [See Table of Tests on page 5.]

### UNIFORMITY

This quality is even more due to the composition and formation of the Natural Cement Rock and the quarry extraction, than to any step in the process of calcination and subsequent preparation for use. When

the cement rock is found in deep sheets or ledges, without intruding dykes of inert or worthless rock, the quarry product is uniform; but when the cement rock occurs in thin or comparatively narrow sheets intersected by dykes of inert material, it will be seen that a mixture of the two will occur in blasting.

The quarries of the American Cement Company, at Egypt, Lehigh County, Pa., offer exceptional opportunities in the matter of composition, uniformity, and extent, presenting a face one hundred feet in height and over a quarter of a mile long. This cement rock is the base of the now famous Portland cements of Pennsylvania, and cement made from it without other admixtures could very properly be called Natural Portland Cements.

This is further emphasized by the fact that Portland Cement cannot be made, even with the assistance of any known admixtures or any process of manufacture, from the Magnesian Limestones of the New York Rosendale or Buffalo districts, the Louisville, Ky., or the Utica, Ill., districts from which the Rosendale cements are made.

TABLE OF CHEMICAL ANALYSIS

BRAND	Silica	Alumi- na	Iron Oxide	Lime	Mag- nesia	Potash and Soda	Carbonic Acid, Water and Loss	Anhyd S. O <sub>2</sub>
"Giant," American, Portland . . . . .	20.91	8.51	2.78	63.05	2.38	....	....	1.63
"Dyckerhoff," Ger- man, Portland . . .	20.64	7.15	3.69	63.06	2.33	....	....	1.39
"Union," Natural, Pennsylvania . . . .	26.36	9.41	3.85	51.24	1.63	1.89	3.06	
"Hoffman," Rosen- dale, N. Y. . . . .	27.30	7.14	1.80	35.98	18.00	6.80	2.98	
"Norton," Rosendale, N. Y. . . . .	27.98	7.28	1.70	37.59	15.00	7.96	2.49	
"Fern Leaf," Rosen- dale, Louisville, Ky.	26.40	6.28	1.00	45.22	9.00	4.24	7.86	
"Hulme," Rosendale, Louisville, Ky. . . .	25.28	7.85	1.43	44.65	9.50	4.25	7.04	
"Utica," Rosendale, Illinois . . . . .	34.66	5.10	1.00	30.24	18.00	6.06	4.84	
"Utica," La Salle, Rosendale, Illinois.	27.60	10.60	0.80	33.04	7.26	7.42	2.00	
"Akron" (Buffalo), Rosendale, N. Y. . .	24.30	2.61	6.20	39.45	6.16	5.30	15.23	

COMPARATIVE TEST TABLE — NATURAL CEMENTS

Table Number	BRAND	Fineness Residue Per Cent.			Rate of Set Minutes		Tensile Strength—Pounds per Square Inch																
		No. 50 Sieve	No. 100 Sieve	No. 180 Sieve	Light Wire	Heavy Wire	1 Day	7 Days	28 Days	3 Mos.	6 Mos.	9 Mos.	1 Yr.	2 Yrs.	3 Yrs.	4 Yrs.	5 Yrs.	6 Yrs.	7 Yrs.	8 Yrs.	9 Yrs.	10 Yrs.	
No. 1	"Union"	Neat	1.0	6.3	13.7	40	90	174	225	298	358	405	...	437	484	500	...	...	...	...	...	...	...
No. 2	"	1 sand, 1 cement	...	...	...	...	...	...	185	278	411	490	...	553	624	660	...	...	...	...	...	...	...
	"	2 " 1 "	...	...	...	...	...	...	116	197	290	382	...	421	461	...	...	...	...	...	...	...	
	"	Neat	...	...	...	10	54	108	159	245	361	424	450	460	453	43	458	465	540	493	515	427	
	"	1 sand, 1 cement	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
No. 3	"	2 " 1 "	...	...	...	...	...	...	89	190	342	441	489	526	574	599	635	677	775	728	744	737	837
	"	Neat	...	...	...	...	...	94	130	...	...	...	...	...	...	...	...	...	...	...	...	...	
	"	3 sand, 1 cement	...	...	...	...	...	...	74	181	236	238	267	312	364	...	...	...	...	...	...	...	
No. 4	"Hoffman"	Neat	3.6	15.6	17.7	...	...	143	154	261	322	304	402	407	418	...	...	...	...	...	...	...	...
	"	1½ sand, 1 cement	...	...	...	...	...	...	66	175	272	280	298	349	312	...	...	...	...	...	...	...	...
No. 5	"Norton"	Neat	3.3	14.2	16.3	...	...	145	158	190	303	...	...	363	451	...	...	...	...	...	...	...	...
	"	1½ sand, 1 cement	...	...	...	...	...	...	72	168	244	272	...	247	273	...	...	...	...	...	...	...	...
No. 6	"Louisville"	Neat	...	23.8	...	...	44	79	135	210	288	348	...	372	...	...	...	...	...	...	...	...	...
	"	1 sand, 2 cement	...	...	...	...	...	...	63	124	227	241	...	249	...	...	...	...	...	...	...	...	...
No. 7	"Akron"	Neat	7.5	17.1	26.0	37	172	259	352	439	457	...	...	...	...	...	...	...	...	...	...	...	...
	"	2 sand, 1 cement	...	...	...	...	...	52	143	226	259	265	...	...	...	...	...	...	...	...	...	...	...

Compare the Strength and Fine Grinding of "Union" Cement with the Rosendale Brands. What Does This Mean to You?

Table No. 1. Metropolitan Water Board, Boston, Mass., report of 1905, average results in testing over 175,000 barrels.

Table No. 4. Metropolitan Sewer Board, Boston, Mass., report of 1903, average results on over 14,000 barrels.

" " 2. From New Croton Dam, N. Y., average results on 125,000 barrels.

" " 5. Same as No. 4.

" " 3. U. S. Engineer, District Columbia, June, 1897, average results on about 30,000 barrels.

" " 6. Taken from Catalogue of Louisville Cement, issued 1901.

" " 7. D. P. W. Phila. Bureau of Surveys, Tests made during 1897-

## HISTORY

The first discovery of Natural Cement Rock in this country was made in 1818 at Sullivan, Madison Co., New York. This resulted from an attempt to produce lime, from a limestone which appeared satisfactory enough, for use in the construction of the Erie Canal then first begun. This lime, however, would not slake, and the matter was called to the attention of Benjamin Wright, Engineer of the Middle Division of the Canal, and fortunately his Assistant, Mr. Canvass White, had just returned from a visit to England, where he had gone to familiarize himself with the materials and methods employed in the execution of great Public Works.

Mr. White had devoted considerable study to the limes and cements used as mortar materials, and found that Parker's "Roman Cement" had passed the experimental stage (1796-1818), and was gradually but steadily supplanting lime as an Engineering Material in both England and France.

With the preliminary information thus gained, Mr. White at once began a series of experiments with this limestone, and as a result of his tests decided that a good Natural Cement, somewhat similar to the "Roman Cement," could be made, in consequence large quantities were produced and used in the locks and walls of the middle section of the Canal during 1818-1819 and thereafter.

From this time Natural Cement was successively and successfully used in the construction of all the canals affording interstate communication, and in all large Public Works, sewers, aqueducts, reservoir dams, bridges, viaducts, retaining walls, important public and private buildings. With the beginning of railroad development, Natural Cement was exclusively used in the heavy masonry structures, culverts, bridges, viaducts, and terminals, and in the above list of important work of all kinds, Natural Cement has stood the "Test of Time," and where not replaced with newer and more modern structures, stands to-day performing its duty without impairment.

With the invention of Portland Cement in England in 1824, and, after a considerable period devoted to experimental use, America began the importation of Portland Cement in small quantities which were used almost exclusively for sidewalks, and other exposed and more difficult situations, and the greatest annual consumption was reached in 1895,

during which year 2,997,395 barrels were imported, while in the same year the production of American Portland Cement amounted to only 990,324 barrels.

In ten years between 1870 and 1880 the United States produced only 82,000 barrels of Portland Cement, and the total production of American Portland Cement up to 1895 had reached 5,275,986 barrels. In view of these figures, it is immensely significant that in Public Improvements and important work constructed between 1818 and 1895 were used more than 144,000,000 barrels of Natural Cement.

Since 1900, almost the entire attention of Cement Manufacturers has been devoted to the production of the artificial higher priced Portland Cements. With the phenomenal growth of this new industry such a demand has been created for men experienced in cement mills that many of the Natural Cement mills have lost their best men and the older industry has been neglected in consequence.

Edwin C. Eckel, C. E., author of the treatise on "Cements, Limes, and Plasters" (published by John Wiley & Sons, 1905), says of Natural cements: "In regard to chemical control of the raw material and product it can be said that, with few exceptions, none is attempted in the American Natural Cement Industry. *The plants of the Lehigh District of Pennsylvania, which are run in connection with Portland Cement plants, are, of course, better off in this respect than the others.* Excluding these Pennsylvania plants, there is, to the writer's knowledge, *only one American Natural Cement plant which employs a chemist — this in North Dakota.*"

The American Cement Company at their modern and well equipped plant at Egypt, Lehigh County, Pa., where they have manufactured the well known "Giant" Portland Cement for twenty-two years, also make the "Union" brand of Natural Cement under the same skilled and experienced supervision in constant attendance, and the splendid results achieved with this cement since 1884 in all kinds of important work, reservoir dams, aqueducts, sewers, street pavement foundations, buildings and retaining walls, are enduring monuments to its strength and economy.

The fine grinding of "Union" Natural Cement is a noticeable feature resulting from the improved methods of manufacture. It is commonly supposed that Portland cements are finer ground than the

Natural or Rosendale cements, but "Union" Cement is a marked exception to this rule, and, as a matter of fact, is finer ground than any Portland Cement made at this time.

## COMPARATIVE VALUE AND ECONOMY

The best grades of Portland Cement attain almost their ultimate strength in from twenty-eight days to three months — continuous tests covering a period of ten years indicate that "Union" Natural Cement makes a quick gain in strength up to three and six months and then a steady increase almost up to ten years without any reactions or setbacks, and in sand mortars the "Union" Cement attains a strength in time not equalled even by the Portland cements, and far in excess of the Rosendale cements from the New York, Louisville, and Illinois districts at all periods of testing.

The foundations and walls of almost all buildings are subjected to compressive strains only, and to use Portland Cement instead of Natural Cement, in the majority of instances, is like using a twenty-four-inch beam when it is known that a twelve-inch beam would amply fill the requirements.

The load on a foundation supporting a granite stone wall 75 feet high does not exceed 6 tons per square foot; 100 feet high, 8 tons, per square foot; 150 feet high, 12 tons per square foot; and 200 feet high, 16 tons per square feet.

Natural Cement showing tensile strength as given below will sustain the loads given in following table :

60 pounds per square inch will sustain a load of from 22 to 35 tons per square foot.													
100	"	"	"	"	"	"	"	"	36	"	57	"	"
150	"	"	"	"	"	"	"	"	54	"	84	"	"
200	"	"	"	"	"	"	"	"	72	"	115	"	"

It is popularly supposed that, at present cement prices, Portland Cement used with three to four parts sand is cheaper than using Natural Cement with only two parts sand, this is not the case and the following illustration will explain the use of the tabulation given below, designed to show the cost of cement to produce a cubic yard of mortar in different combinations with sand.

## Assumptions: —

Natural Cement costing \$0.92 per barrel in bags  
 Portland “ “ 1.58 “ “ “  
 Sand “ .75 “ cubic yard.

A cubic yard of mortar of 1 cement to 2 sand would require

3.32 barrels Natural Cement at 92 cents	\$3.06	
0.93 cubic yard sand at 75 cents	.70	\$3.76

A cubic yard of mortar of 1 cement to 3 sand requires

2.48 barrels Portland Cement at \$1.58	\$3.92	
1.05 cubic yard sand at 75 cents	.79	\$4.71

A cubic yard of mortar of 1 cement to 4 sand requires

1.98 barrels Portland Cement at \$1.58	\$3.13	
1.11 cubic yard sand at 75 cents	.83	\$3.96

It is thus shown that even at the low price given for Portland Cement, and using it with four parts sand, it costs more than a high-grade Natural Cement, and it is, of course, well known that a four to one mortar would be porous.

It is also known that a mason can and will lay up more brick or stone masonry per day using a rich mortar, such as two to one, because of its plasticity. The sandy mortars are what the mason calls “short” and “gritty,” and it is also well to bear in mind that a four to one mortar carelessly mixed may in portions of the “batch” be no better than five or six to one, and the weakest link in the chain is the measure of its strength.



SIDEWALKS AND CELLAR FLOORS					
Yield of One Barrel of Portland Cement					
Mortar Proportions	AREA COVERED IN SQUARE FEET				
	$\frac{1}{4}$ inch thick	$\frac{1}{2}$ inch thick	$\frac{3}{4}$ inch thick	1 inch thick	
1 Cement to $1\frac{1}{2}$ sand	343	172	115	86	
1 " " 2 "	418	209	139	104	
1 " " $2\frac{1}{2}$ "	493	246	164	123	
1 " " 3 "	575	287	191	144	
Concrete Proportions	3 inches thick	4 inches thick	5 inches thick	6 inches thick	12 inches thick
1 Cement, 2 sand, 4 stone { a	73.97	55.48	44.38	36.99	18.49
{ b	72.97	54.73	43.78	36.49	18.24
1 " 2 " $4\frac{1}{2}$ " { a	79.41	59.56	47.65	39.71	19.85
{ b	78.26	58.69	46.96	39.13	19.56
1 " 2 " 5 " { a	85.04	63.78	51.02	42.52	21.26
{ b	83.72	62.79	50.23	41.86	20.93
1 " $2\frac{1}{2}$ " 5 " { a	90.75	68.07	54.45	45.38	22.69
{ b	89.25	66.94	53.55	44.62	22.31
1 " $2\frac{1}{2}$ " $5\frac{1}{2}$ " { a	95.57	71.68	57.34	47.78	23.89
{ b	93.91	70.43	56.35	46.96	23.48
1 " 3 " 6 " { a	106.93	80.20	64.16	53.47	26.73
{ b	105.88	79.41	63.53	52.94	26.47
1 " $3\frac{1}{2}$ " 6 " { a	113.68	85.26	68.21	56.84	28.42
{ b	111.34	83.50	66.80	55.87	27.83
NOTE:— For mortar-work plastering, 2% for waste was allowed. For concrete (a) figures are for stone 1 inch and under, dust screened out. For concrete (b) figures are for stone $2\frac{1}{2}$ inches and under, dust screened out.					

Compiled by E. S. LARNED, C. E.

COMPARATIVE COST OF CONCRETE  
(Materials)

MIXTURE	* REQUIRED			COST (Assumed)			TOTAL
	Cement bbls.	Sand cu. yd.	Stone cu. yd.	Cement	Sand	Stone	
I Cem., 2 sand, 4 stone	1.57	0.44	0.88	0.95	0.50	1.60	\$3.12 Natural
I " 2 " 4 "	1.57	0.44	0.88	1.65	0.50	1.60	4.22 Portland
I " 2 " 5 "	1.39	0.39	0.98	0.95	0.50	1.60	3.09 Natural
I " 2 " 5 "	1.39	0.39	0.98	1.65	0.50	1.60	4.06 Portland
I " 2½ " 5 "	1.30	0.46	0.92	0.95	0.50	1.60	2.94 Natural
I " 2½ " 5 "	1.30	0.46	0.92	1.65	0.50	1.60	3.85 Portland
I " 3 " 6 "	1.11	0.47	0.94	0.95	0.50	1.60	2.79 Natural
I " 3 " 6 "	1.11	0.47	0.94	1.65	0.50	1.60	3.57 Portland
I " 3 " 7 "	1.01	0.43	0.99	1.65	0.50	1.60	3.47 "
I " 4 " 7 "	0.92	0.52	0.91	1.65	0.50	1.60	3.24 "
I " 4 " 8 "	0.85	0.48	0.96	1.65	0.50	1.60	3.18 "
I " 4 " 9 "	0.80	0.45	1.01	1.65	0.50	1.60	3.17 "
I " 5 " 10 "	0.69	0.49	0.97	1.65	0.50	1.60	2.94 "

NOTE: — Based on barrel of 3.8 cubic feet.  
          Voids in stone or gravel assumed 45 per cent.

NOTE: — A barrel of "Union" Cement will make as much mortar in volume as a barrel of Portland Cement used with the same proportion of sand.

You know, of course, that a barrel of cement will not fill the voids in more than three barrels of ordinary sand — sand contains from 30 per cent. to 45 per cent. voids — and is it not wise to allow a small surplus of cement to guard against careless and imperfect mixing?

\* Proportions taken from Taylor & Thompson's book on "Concrete — Plain and Reinforced."

Cost of Cement per Cubic Yard of Mortar (Compacted)						
Mixture	1-1½	1-2	1-2½	1-3	1-3½	1-4
Cement, barrels required	4.00	3.32	2.84	2.48	2.20	1.98
Sand, cubic yard required	0.84	0.93	1.00	1.05	1.08	1.11
Cement at \$0.72	\$2.88	\$2.39	\$2.04	\$1.79	.....	.....
" " .77	3.08	2.56	2.19	1.91	.....	.....
" " .82	3.28	2.72	2.33	2.03	.....	.....
" " .87	3.48	2.89	2.47	2.16	.....	.....
" " .92	3.68	3.06	2.61	2.28	.....	.....
" " .97	3.88	3.22	2.75	2.41	.....	.....
" " 1.02	4.08	3.39	2.90	2.53	\$2.24	\$2.02
" " 1.07	4.28	3.55	3.04	2.65	2.35	2.12
" " 1.12	4.48	3.72	3.18	2.78	2.46	2.22
" " 1.18	4.72	3.92	3.35	2.93	2.60	2.34
" " 1.23	4.92	4.09	3.49	3.05	2.71	2.44
" " 1.28	5.12	4.25	3.64	3.17	2.82	2.53
" " 1.33	5.32	4.42	3.78	3.30	2.93	2.63
" " 1.38	5.52	4.59	3.92	3.42	3.04	2.73
" " 1.43	5.72	4.75	4.06	3.55	3.15	2.83
" " 1.48	5.92	4.91	4.20	3.67	3.26	2.93
" " 1.53	6.12	5.08	4.35	3.79	3.37	3.03
" " 1.58	6.32	5.25	4.49	3.92	3.48	3.13
" " 1.63	6.52	5.41	4.63	4.04	3.59	3.23
" " 1.68	6.72	5.58	4.77	4.17	3.70	3.33
" " 1.73	6.92	5.74	4.91	4.29	3.81	3.43
" " 1.78	7.12	5.91	5.06	4.41	3.92	3.52
" " 1.83	7.32	6.08	5.20	4.54	4.03	3.62
" " 1.88	7.52	6.24	5.34	4.66	4.14	3.72
" " 1.93	7.72	6.41	5.48	4.79	4.25	3.82
" " 1.98	7.92	6.57	5.62	4.91	4.36	3.92
" " 2.03	8.12	6.74	5.77	5.03	4.47	4.02
" " 2.08	8.32	6.91	5.91	5.16	4.58	4.12
" " 2.13	8.52	7.07	6.05	5.28	4.69	4.22
NOTE. Brickwork requires 0.333 cubic yard mortar per cubic yard in place						
Rubble masonry	"	0.300	"	"	"	"
Ordinary concrete	"	0.500	"	"	"	"

Compiled by E. S. LARNED, C. E.

## Bear in Mind

That "Union" Cement has been used by prominent Engineers and Architects for many years with entire success, satisfaction and economy in the —

Foundations and Superstructures of  
important Public and Private Buildings —  
Bridge foundations and Viaducts —  
Pavement foundations and Sewers —  
Reservoir Dams and large Aqueducts —  
Retaining Walls and Fortifications —  
Telephone, Telegraph, and Electric-  
Light Conduits, etc.

## Why?

Because Union Cement is made from rock of superior and uniform composition and has the advantage of the same experienced and skilled superintendence that is required in the manufacture of Portland Cement — the accumulated experience since 1884.

## You

Are the Judge of what your work requires from the standpoint of strength and economy — consider well the foregoing statements and if you have never used "Union" Cement, try it and you will find an increased use for this grade of Natural Rock Cement.

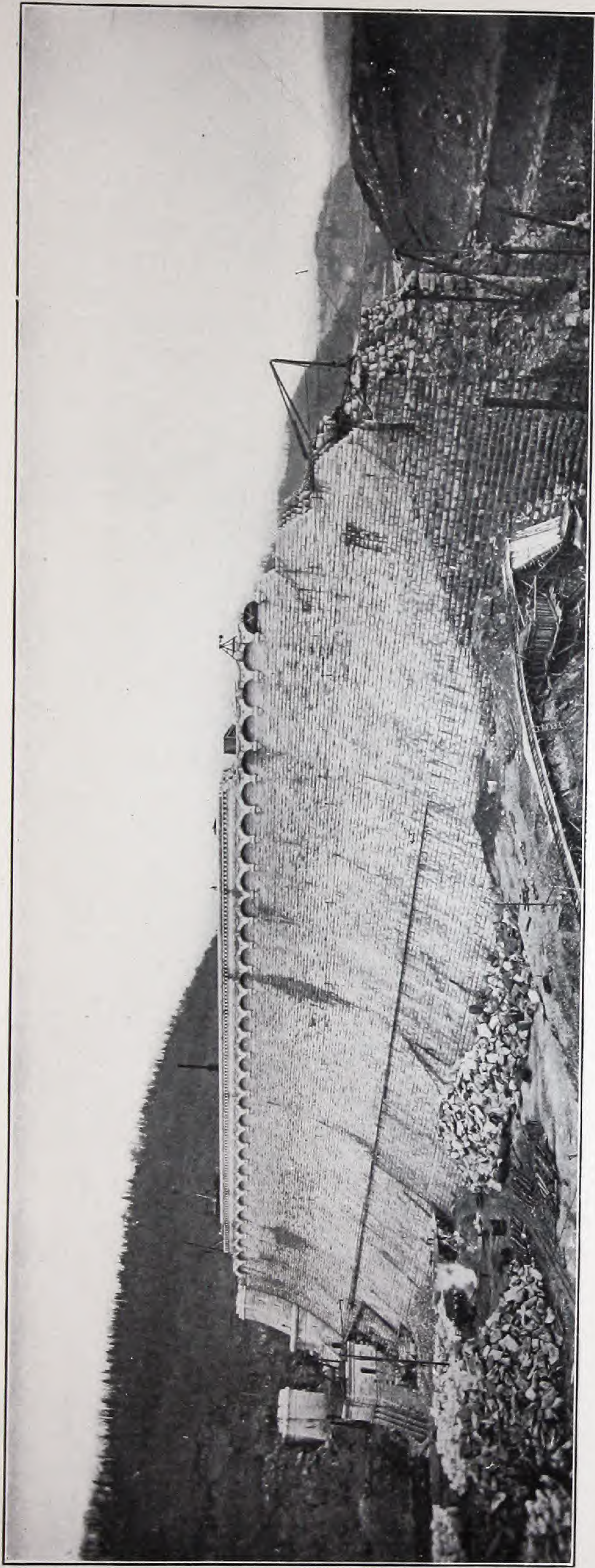
## IF

Your work requires Portland Cement use "Giant," it has stood the "Test of Time" and has been used for over twenty years by prominent engineers, architects, contractors and builders in the most difficult and important construction ever undertaken in this country.

Under conditions of exposure to extreme heat and intense cold ; in salt, fresh, and acidulated waters ; in foundations of quicksand, soft clay ; in pneumatic foundations, rock tunnels, soft ground tunnels, subaqueous tunnels, reinforced concrete construction, fireproofing, etc., "Giant" Portland Cement has been tried and proved "strong," "sound," and "permanent."

Write for our Booklet "The Test of Time."





### NEW CROTON DAM — NEW YORK AQUEDUCT SYSTEM

Length of Dam, including overflow, 1,700 feet.  
J. Waldo Smith, Chief Engineer.

Width at bottom, 200 feet.

C. S. Gowen, Division Engineer.

Built of "Giant" Portland and "Union" Cements

Completed 1905-6.

See Tests of "Union" Cement in Table No. 2.

Extreme Height, 290 feet.  
Contractors: Coleman, Breuchaud & Coleman.

Storage Capacity, 32,000,000 gallons.

#### Results of the Tests of "UNION" Natural Cement:

"Neat tests show a comparatively quick rise in 9 months to 450 pounds per sq. in., a slight further rise in 21 months, to 480 pounds, falling off in three years to 450 pounds and showing after five years later successive rises and falls to 9 years, reaching its maximum at 540 pounds at 6 years and falling to 430 pounds at 9 years.

"Sand tests (2 to 1) show a quick rise in 6 months to 440 pounds per sq. in. and beyond this a steady gain varied by only one high point in the curve, at 6 years, up to 10 years. Between the six and the ten year points the successive years show an average breaking weight of about 850 pounds which is greater than for Portland Cement for the same time."

Write for our Booklet, "The Test of Time."

From Article by C. S. Gowen, Division Engineer.



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